B3.0 ENVIRONMENTAL IMPACTS

B3.1 INTRODUCTION

The development of a National Training Center would have different levels and types of impacts on different areas of the natural and socioeconomic environment. Proposed maneuvers associated with force-on-force warfare simulation would affect the reservation as a whole, with impacts primarily on the natural environment. The influx of large numbers of personnel to the base would have a dramatic impact on the cantonment area, where thousands would be housed. Impacts would include increased demand for water for domestic use, and for sewage treatment. In addition, the on-post population would be subject to high noise levels from Army maneuvers. The National Training Center would also create a demand for off-post labor and resources for construction and rehabilitation of Fort facilities, as well as for ongoing civilian support operations. This increased direct and indirect employment force would generate population increases in the Barstow area, with significant impacts on the economic and social environments of the Barstow area.

Because of the differing types and levels of impacts on the environments of the reservation as a whole, the cantonment area, and the Barstow area, impacts on environmental factors are considered separately for each of the three areas. Environmental factors considered for each area are as follows:

The Reservation:

- Use of Fire and Maneuver Areas
- Natural Conditions
  - Air Quality
  - Soils
  - Vegetation
  - Wildlife
- Archaeologic and Historic Resources
- Aesthetic Quality
- Radio Interference
- Energy

The Cantonment Area:

- Water Supply
- Sewage Treatment and Waste Disposal
- Noise
- Energy

The Barstow Area

- Economic Conditions
  - Population
  - Employment
  - Income
  - Retail Sales
- Housing
- Community Services
  - County and Special Districts
  - Health Services
  - Education
  - Parks and Recreation
  - Public Safety
  - Transportation
- Energy

The probable impacts of the proposed National Training Center on each of the above environmental factors is described, by area, in the following sections. The use of the future tense is for convenience, as the Center is still a proposal and all impacts discussed are conditional on the proposal being implemented.

THE RESERVATION

B3.2 USE OF FIRE AND MANEUVER AREAS

Should implementation of the proposed action be completed, the use of the Fort Irwin Reservation for field training exercises will increase by roughly 75% over fiscal year 1978 use levels. Table B-1 summarizes use levels of rotating transient troops who will come to Fort Irwin to train. It is expected that regular Army rotations will be increased from three per year in 1978 to ten per year by 1980. The pattern of use will change utilizing those areas shown in Figure 2, Proposed Ranges and Maneuver Area. Platoon level training will not be conducted at Fort Irwin by the Army. The existing courses established for units at less than company strength will accordingly not be used more than at present. Such ranges include Tarantula, Scorpion, Lizard Gulch, and Coyote Canyon Ranges (Figure 10, Reference Nos. 7, 8, 9, and 10 respectively).

Table B-1. Fort Irwin Projected Transient Use in Man Months

Fiscal Year (FY)	Unit	Troops
FY '78	Army Reserve National Guard Annual Training[a]	7,500
	Army Reserve National Guard Weekend Training[b]	2,400
	Forces Command[c]	3,500
	TOTAL FY '78:	13,400
FY '80-81	Army Reserve National Guard Annual Training	7,500
	Army Reserve National Guard Weekend Training	2,400
	Forces Command[d]	7,500-10,500
	TOTAL FY '80-81	16,900-20,400
FY '82-83	Army Reserve National Guard Annual Training	7,500
	Army Reserve National Guard Weekend Training	2,400
	Forces Command[e]	17,500
	TOTAL FY '82-83	27,400
FY '84	Army Reserve National Guard Annual Training	7,500
	Army Reserve National Guard Weekend Drills	2,400
	Forces Command[f]	40,250
	TOTAL FY '84:	50,150

a) 15,000 troops for 5, 2 week rotations.
b) Assumes 1,000 personnel for 36 weekends = 1,000 troops for 72 days or 2.4 months = 2,400 troops/month.
c) Assumes 2 brigades per year at 3,500 troops per 2-week intervals.
d) Assumes 4 to 6 brigades per year at 3,500 troops/2-week intervals.
e) Assumes 10 brigades per year at 3,500 troops/2-week period intervals.
f) Assumes 21 brigades per year at 3,500 troops/2-week period intervals.

The east tank firing ranges (Figure 10, Reference Nos. 18 through 22), will continue to be used as they are now by the California National Guard units on weekend and annual training duty. Forces Command activities will be scheduled in such a manner so as not to interfere with these activities. Coordination will also be made with the California National Guard in defining impact areas compatible with all uses of the reservation.

B3.3 NATURAL CONDITIONS

The natural elements which form the desert landscape of Fort Irwin, that is the dry soil, the scrub vegetation, the animal populations and the atmospheric conditions, have been altered to some extent every time man has been present there in any quantity of numbers. The signs of man can easily be seen today: prehistoric rock circles, wagon trails and mineshafts from the nineteenth century; and intensive development of buildings, paved roads, random tank trails, ranges, man-made ponds, golf course, space communications equipment and the like. The desert environment with its arid climate preserves such evidence of use.

Because of considerable human use, the desert of Fort Irwin is altered from its natural state. For the most part, neither the extent nor the rate of change on the desert environment has been quantified.

Expanded military use of the Fort Irwin Reservation by 75% will increase the intensity of activities causing physical change and most likely will speed up the rate of such change.

The use of wheeled and tracked vehicles on the desert damages the soil, destroys plants, animal habitat, and animals, and at times, generates vast quantities of dust. While some of these effects will be experienced only on the site and its immediate surroundings, the creation of dust, for instance, has far reaching significance, as suspended particulate matter generated in the Mojave Desert is carried nationwide by the earth's wind circulation system.

Long-term use as a military training center has and will continue to promote physical change in the character of the Fort Irwin desert. For example, Figure 11 shows an area of moderate use in the South Tiefort Range where vegetative cover has been reduced by repeated tracking. Figure 12, the main tank trail leading southeast from the cantonment area to the Rockpile and South Tiefort Ranges, shows that heavy and repeated use has elimiated vegetation and destabilized the desert surface.

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The ongoing and increased use of Fort Irwin for wheeled and tracked vehicle training and maneuvers will continue to cause the most damage to the desert surface. As in the past, the disturbance of the desert will occur principally in the alluvial fill valleys and not on the steeper hill-slopes and mountains. An estimated 60 percent of the Fort Irwin land surface is trafficable by tracked vehicles and 50 percent trafficable by wheeled vehicles. The trafficable areas coincide, for the most part, with the alluvial valleys which are shown on Figure 5.

The effect of increasing and concentrating use by tank battalion rotations in the two maneuver areas described in Section 3.2 is expected to be an increase in soil disturbance and erosion rate.

The approach taken has been to identify the mechanisms and types of impacts that occur when vehicles are used on the desert. It is in this light that the following sections discuss the expected impacts on natural conditions of the Fort Irwin Reservation.

B3.3.1 Soils

Desert training activities that result in direct effect on the soil include the use of wheeled and tracked vehicles on the desert surface, the establishment of bivouac sites and the impact of live fire ordnance from both aircraft and ground sources. Of these, the most apparent and widespread on Fort Irwin is the use of vehicles on the desert. For this reason the discussion of impacts on soils focuses on the effects of vehicle use.

The use of wheeled and tracked vehicles on the Fort Irwin desert has several direct effects on the soil:

- Direct mechanical action exerts compaction and shear forces on the soil surface.
- Lag gravels that make up desert pavement or armor are disturbed.
- Disturbance of other soil stabilizers including vegetation, chemical and algal crusts.
- Disturbed soil becomes more susceptible to subsequent erosion by water and wind.
- Fine particles (dust) are propelled into suspension.

A. Direct Mechanical Action

In general, the degree of soil damage is proportional to the energy applied to the soil (Harrison, 1975). Compaction alters the structure of the soil, with resultant effects such as increasing of overall density and eliminating pore spaces that allow for movement of air and water into and out of the soil. Shear is movement of soil particles with reference to one another, a grinding effect, which also alters the structure of the soil.

Soil structural damage sustained by vehicular passage is strongly dependent on moisture content at the time of impact; hence, a small vehicle load at one time of the year may cause substantially more soil damage than a much larger load at another time of the year. In terms of erosional consequences of disturbance, there are thresholds of damage that, when exceeded, result in highly accelerated erosion rates. The Department of Interior's observations in desert terrain indicate that such thresholds are commonly exceeded by passage of a small number of vehicles, in many cases a single passage being sufficient. Thus, while increased energy transfer to the soil will increase soil damage, it may not, after very low tolerances are exceeded, add greatly to potential sediment yield. In this respect, the total area disturbed is more important than the intensity of disturbance.

When a vehicle travels on any ground surface, at least four things happen to the soil (Wilshire, 1975).

- A zone of compression forms beneath wheels or tracks.
- The zone of compression is enveloped by shallow zones of expansion and shear stress.
- Tires or tracks generate shallow lateral shear stress perpendicular to the direction of vehicle travel.
- Forward motion imparts powerful shear stress at the surface parallel to the direction of travel.

Both compaction and shear stresses disturb the soil structure and result in physical changes. Depending on soil structure and particle size distribution, compaction decreases air spaces between soil particles, alters the capacity to hold water, alters the ability of water to move through the soil, and increases the diurnal temperature range of the soil (Webb, 1977; Ragland, 1977).

Both wheeled and tracked vehicles impart shear stress to the soil, although tracked vehicles generate greater shear stresses than pneumatic rubber tired vehicles. This is due, in part, to the "skid steering" turning behavior of tracked vehicles whereby one track is speeded up relative to the other to change direction. Figure 17 shows the results of the increased lateral shear stress exerted on the soil where the tracks turn.

B. Disturbance of Desert Pavement

On Fort Irwin, where ground cover is sparse, with only 5 to 20 percent vegetation coverage, the surface is protected by lag gravels, that is, particles too large to be transported by sheetwash or wind action and which remain after the fine particles have been carried away. This protection layer of residual particles is variously called desert pavement or desert armor.

Disturbance of the desert pavement exposes a soil mix of cobbles, pebbles, sands and finergrained materials, and promotes accelerated erosion.

C. Increased Erosion Potential

With the stabilizing soil surface broken, the fine particles are exposed to water and wind erosion. Water will carry the fines downslope to be redeposited in washes and flats (Wilshire, 1977). In the broad washes, the fines are easily blown away by strong winds.

While the redevelopment of a lag gravel armor can be expected where a single track is left on the desert, constant or recurrent use of an area by vehicles will continuously expose the desert surface to erosion.

D. Generation of Dust

Vehicles operating on the desert surface will cause mechanical and wind erosion of fine particles of dust. Under natural conditions, fine soil materials will remain on the surface unless winds attain a threshold velocity high enough to pick them up. The creation of wind fetches from vehicular and human trampling may compound this effect. In the layer near ground level, the velocity of air tends toward zero due to surface roughness. Vegetative cover also screens and protects the soil surface by providing a shelterbelt effect. Destruction of vegetation makes the soil more susceptible to erosion.

The mechanical action and air currents caused by wheeled and tracked vehicles on the desert floor result in the mechanical lifting of fine soil particles off the soil surface and into the air above the sheltered boundary layer, where they become suspended particulate matter or dust. Figure 18 illustrates the results of mechanical action of a tank operating on previously heavily tracked and altered desert surface immediately adjacent to the cantonment area.

3.3.2 Air Quality

Conversion of Fort Irwin to a National Training Center will result in new stationary and mobile sources of air pollution. New stationary sources will include two equipment maintenance ships, fuel storage facilities, pumping sites, and new boilers and incinerators. New mobile sources will include jet aircraft, diesel- and gasoline-fueled military vehicles, and personal vehicles owned by Fort Irwin personnel. Approximately 1,000 off-post employees will travel over the Barstow-Fort Irwin access road to the Fort each day.

The proposed project will lead to a negligible increased emission in levels of carbon monoxide, nitric oxides, sulfur oxides, reactive hydrocarbons, and significant increases in primary particulates. Conditions conducive to the buildup of CO concentration levels include limited ventilation (e.g., low wind speeds), stable atmospheric conditions, and congested traffic. However, the likelihood that the projected increase in automotive traffic by 1,000 vehicles will lead to violations of the federal 1 or 8 hour average carbon monoxide levels is extremely remote. Composite CO emission factors for the anticipated 1984 California vehicle fleet were computed using the methodology developed by Pollack and Austin (1978). This procedure represents a refinement to the EPS procedure for estimating composite exhaust emissions. Assuming a composite emission factor of 6.66 gm/mile for an average route speed of 55 miles per hour, the total CO emissions from 1000 vehicles traveling the 37 miles from Barstow to Fort Irwin would be approximately 250 kg. For these emissions alone to create a violation of the 1 hour primary standard of 40 mg/m^3, they would have to be confined to a cubic volume of air approximately 625 meters on a side. Atmospheric transport and dispersion preclude the possibility that CO emissions would ever be confined to a volume of this size for periods on the order of an hour.

1984 emissions factors for diesel-fuel heavy duty trucks at an average route speed of 20 mph were computed to be 27.3 gm CO/mile. Assuming that a total of 239 tanks and tracked vehicles and 196 wheeled vehicles were driven a total of 20 and 25 miles per day, respectively, the total daily CO

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emissions would amount to only approximately 310 kg -- and amount unlikely to jeopardize compliance with the National Ambient Air Quality Standards (NAAQS).

Because the Southeast Desert Air Basin has been designated as a non-attainment area for photochemical oxidant, the potential impact of increased hydrocarbon and NO_x emissions on oxidant concentrations (primarily NO_2 and O_3) must be addressed. A simple screening analysis can be used to estimate the likelihood that increased emissions from passenger automobiles, trucks, tracked vehicles, and other heavy duty vehicles might be sufficient to influence ambient oxidant levels. The total daily hydrocarbon and NO_x emissions for a 1984 fleet of 1000 vehicles making the (55 mph) round trip journey between Barstow and Fort Irwin would be approximately 100 and 175 kg/day, respectively. The corresponding daily emissions from 329 tank and tracked vehicles and 196 wheeled vehicles traveling 20 to 25 miles per day, respectively, would be 50 kg (hydrocarbon) and 200 kg (NO_x). Thus, the increased activity at Fort Irwin might lead to increased daily emissions of hydrocarbon and NO_x of 150 kg and 375 kg.

Air masses arriving at Fort Irwin under southwest wind conditions would likely contain an "aged" mixture of pollutants originally emitted in the South Coast Air Basin. Due to aging and the gradual removal of NO_x ratio would increase over that typical of an urban mix. A value of 10 might be a lower bound.

The screening procedure may be described as follows. Suppose that instead of the total daily hydrocarbon and NO_x emissions begin temporally and spatially distributed across Fort Irwin they were initially introduced into an outdoor smog chamber and allowed to react, forming ozone. Because the ozone formation potential of the atmosphere is dependent upon the concentration of the various reactants, it is of interest to estimate the maximum size of the reaction volume within which elevated ozone concentrations might be formed. For this analysis, we choose 0.08 ppm as the peak concentration level.

Based upon (1) an ozone (EKMA) isopleth developed for the South Coast Air Basin (Tesche 1978), (2) an assumed hydrocarbon to NO_x ratio of 10, and (3), a peak one hour average ozone level of 0.08 ppm, the estimated maximum size of the reaction volume in which this level of ozone could be produced is a cube only 1,500 meters on a side.

Because the spatial and temporal scales over which the projected emissions are expected to be distributed is considerably larger than those assumed in the above screening analysis, one may reasonably conclude that the impact of increased emissions from Fort Irwin will not have a measurable impact on oxidant air quality.

In contrast to CO and oxidant air quality for which minimal impacts are envisioned, development of Fort Irwin into a National Training Center may lead to non-negligible impacts on suspended particulate levels. Estimates of the potential increases in particulate concentrations are given below.

Windblown suspended particulates from desert pavement may be estimated through the use of the so-called wind erosion equation (Richard et al., 1977):

$$E_s = AIKCL'V'$$

E_s = Suspended particulate fraction of soil wind erosion losses, tons/acre/year
A = Portion of total wind erosion losses that would be measured as suspended particulate
I = Soil erodibility, tons/acre/year
K = Surface roughness factor, dimensionless
C = Climatic factor, dimensionless
L' = Unsheltered field width factor, dimensionless
V' = Vegetative cover factor, dimensionless

The variable of greatest uncertainty in this empirical relationship is the suspension factor, A, which depends upon the material properties of the soil constituting the desert pavement. For undisturbed desert soil surfaces Gillette (1974) estimates the value of A = 0.018. For disturbed nature soils, such as would exist subsequent to disruption of the pavement by vehicle activity, A is thought to vary between .009 and .067. Richard et al. (1977) suggests that, in light of the uncertainties associated with these numbers, a mean value (0.038) should be used for distributed nature soils.

The soil erodibility index (I) has been estimated for Nevada desert soils (Shinn, 1974; Gillette, 1974) composed of roughly 30 percent silt (particles 84 pm) to be approximately 10 tons/acre/year. When the soils are consolidated, as they are in typical desert pavement, Woodruff and Siddoway (1965) suggest a lower value of 1.66 ton/acre/year.

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The climatic factor C in equation (1) is given by:

$$C = 0.345 \frac{W^3}{PE^2}$$

where W is the average windspeed (mph) and PC is Thornthwaite's Precipitation Evaporation Index.

Based upon the historical weather data presented by Bennet (1975) for China Lake, Thornthwaite's Precipitation Evaporation Index was calculated according to the methodology prescribed by Richard et al. (1977). An annual mean value of P = 4.2 was obtained. Assuming a mean summer wind speed of 9 mph, the climatic factor, C, is 14.26.

Because the desert surface at Fort Irwin represents an uninterrupted erosion surface for great distances, the unsheltered distance factor L' is assumed to be unity. Following Richard et al. (1977), the vegetation cover factor is assumed to be 0.9, reflective of intermittent scrub vegetation, and K, the surface roughout factor, is unity, typical of unpaved roads.

Based on the above assumptions, fugitive particulate emissions rates may be estimated. For undisturbed desert pavement,

$$E_s = (0.018)(1.67)(1.0)(14.26)(1.0)(.9)$$
$$E_s = .39 \text{ tons/acre/year.}$$

For a disturbed desert pavement, e.g., one in which the surface crust has been disintegrated, the particulate emission factor becomes:

$$E_s = (0.38)(10.0)(1.0)(14.26)(1.0)0.9$$
$$E_s = 4.88 \text{ tons/acre/year}$$

On a daily basis, these emission factors are:

Undisturbed Pavement $E_s = 0.97$ kg/acre/day
Disturbed Pavement $E_s = 12.13$ kg/acre/day

Based on these admittedly crude estimates, one might expect the erodibility of a disintegrated desert soil in the vicinity of Fort Irwin to roughly an order of magnitude greater than undisturbed desert pavement.

Of course, the effective emission factor for fugitive dust at Fort Irwin depends upon the fraction of the area for which the desert pavement is disturbed. That is,

$$E_{eff} = (1 - a)E_o + aE_d$$

where,

E_{eff} = effective particulate fraction of soil and erosion loss, kg/acre/day

Eo = effective particulate loss from undisturbed desert pavement, kg/acre/day

Ed = effective particulate loss from disturbed desert pavement, kg/acre/day

a = fraction of land area disturbed

Thus, for mean conditions (e.g., average climatic factors).

$$E_{eff} = 0.97\ (1 - a) + 12.13a \qquad (4)$$

To estimate the relative increase in particulate loading under mean water conditions, it is necessary to define the surface areas which are disturbed and undisturbed. Assuming the entire 642,582 acres of Fort Irwin represent undisturbed desert pavement, under the mean climatic condition assumed in estimating the above emissions factors, roughly 6 x 10^5 kg of fugitive dust would be transported by the wind in a day. Of course, even with development a sizeable fraction of the reservation may be expected to remain undisturbed, although the exact area cannot be given. Assuming that roughly 62 percent of the land area is dedicated to maneuvers and of this area approximately 25 percent of the soil surface is disturbed, the mean effective erosion rate would be on the order of 17 x 10^5 kg per day which amounts to roughly a factor of three increase in the erosion rate compared to pristine conditions.

The capacity of the wind to erode desert pavement and keep the soil particles suspended depends on numerous factors such as wind speed, soil composition, antecedent precipitation, and so on. Because it has been found that the mass transport rate of suspended dust is a power law function of wind speed, greater erosion and resuspension rates will occur under high wind conditions compared with mean climatic conditions. Furthermore, because the erosion rate (given by

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the wind erosion equation) is non-linearly related to near surface wind speed* the relative increase in erosion rate over disturbed compared to undisturbed soils can be expected to change as wind speed increases above the climatic mean value.

Because the Southeast Desert Air Basin has been declared a nonattainment area for suspended particulate matter, and due to Fort Irwin's proximity to renowned area of scenic beauty, an estimate of potential visibility degradation is appropriate. Fortunately, estimation of visibility impairment due to windblown dust is easier than the reduction in visibility due to anthropogenically derived secondary urban aerosols.

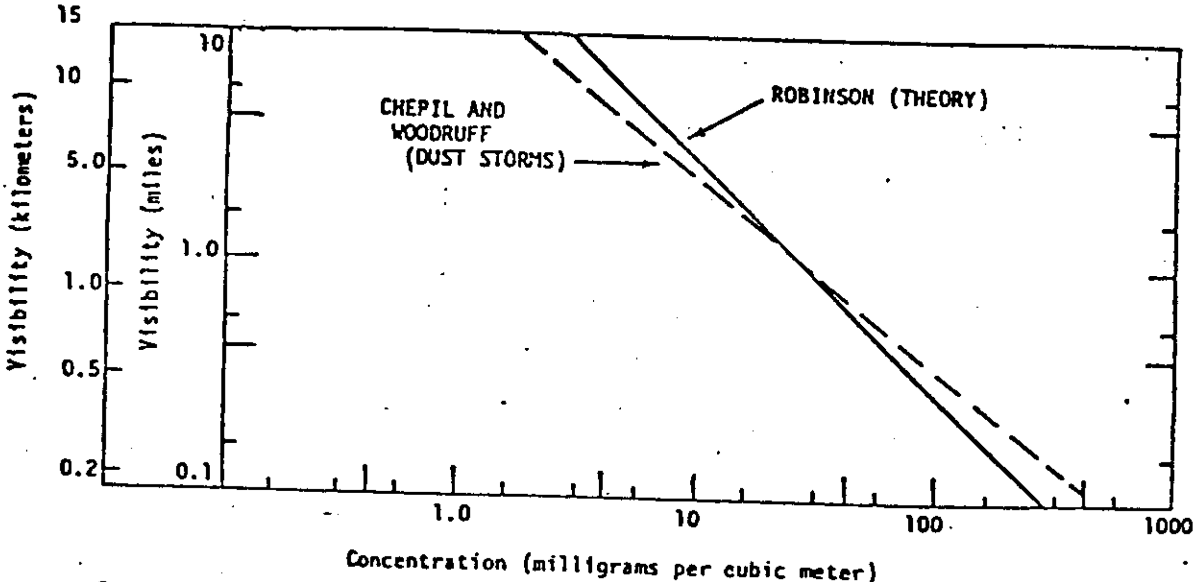
Simple estimates of visibility reduction due to wind blown dust may be made based upon the experimental results reported by Chepil and Woodruff (1957). They found that dust concentrations 6 feet above the ground surface was related to visibility according to the relation.

$$C = 56.0V^{-1.25}$$

where V is the horizontal visibility in kilometers. The general form of this relationship for windblown dust was also derived by Robinson (1968) in a theoretical study. Figure 1 shows these results.

In a preceding analysis, we estimated that under pristine, average conditions, the daily erosion rate of particulate material from the Fort Irwin site might be on the order of 6×10^5 kg per day. If this material were uniformly mixed throughout the Fort Irwin Site and beneath a 1,000 meter inversion, the mean resultant particle concentration would be approximately 0.2 mg/m^3 which would limit visibility to roughly 90 km. This is about one-half the distance one can see in a clean atmosphere wherein visibility is limited by Raleigh scattering.

* The climatic factor 'C' is proportional to the third power of the wind speed.



Source: Hagen and Woodruff (1973).

FIGURE 1. VISIBILITY RELATED TO PARTICULATE CONCENTRATION

Under the assumptions listed earlier, (in which a portion of the basis desert pavement is disturbed due to maneuvers) future particulate emission rates under climatic mean conditions might approach 17 x 10^5 kg. In this case, visibility might be reduced to 35 km.

Of course, the above calculations are gross simplifications of a very complex set of atmospheric processes. Although the present state-of-the-art in visibility modeling does permit the quantification of visual range reduction given proper characterization of suspended atmospheric aerosols [Latimer, et al. (1978)], the inherent uncertainties in the rates at which desert soils are eroded make it difficult to identify precisely the degree of visibility reduction expected as a consequence of the proposed project.

An important air quality concern related to development of Fort Irwin is the possible adverse health effects due to increased suspended particulate matter. In considering potential health effects, it is necessary to examine both the source of the suspended particulate matter and its physical and chemical properties.

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Windblown dust is similar in chemical composition and particle size distribution to the soil from which it is derived. In the vicinity of Tucson, Arizona, for example, the chemical composition of fugitive dust contains a relatively high percentage of silicon and aluminum -- reflecting the crustal origin of the material -- and relatively low concentrations of elements such as lead, cadmium, and nickel (University of Arizona, 1975). In a recent study commissioned by the Arizona Public Service Company, the particle size distribution of windblown dust collected near the Palo Verde Nuclear Generating Station site was determined for fugitive dust collected during three separate windstorms. Less than 6 percent of the mass of this material was accounted for by particle sizes smaller than 20 μ in diameter. Only particles 2 μ or smaller in diameter are capable of penetrating into the deep lung, and particles larger than 15 μ in diameter are excluded even from the nasopharyngeal region of the human respiratory tract [Simmons, Liu, and Walton (1978)]. Thus, only a small fraction of the suspended particulate matter contained in windblown dust is capable of being inspired into the human respiratory tract.

Clearly, three important factors differentiate fugitive dust from industrial particulate emissions and cause the former to be considerably less hazardous to human health than the latter:

> Fugitive dust does not contain the polycyclic organic matter characteristic of the incomplete combustion of fossil fuel.
>
> Only a relatively minor fraction of fugitive dust is composed of particles small enough to be inspired into the human respiratory tract.
>
> The trace elements known to be toxic to man, such as nickel, copper, and cadmium, among others, appear in fugitive dust in concentrations far below those required to produce an adverse human response.

Finally, the potential size of suspended dust is contributing to Valley Fever should be considered. Valley Fever is transmitted by a fungus which adheres to airborne particulate matter. The source of the fungus is living organic matter contained within the upper soil layers. Primary source regions for the fungus are fields under irrigated agriculture. However, in the desert region surrounding Fort Irwin, insufficient vegetation exists to provide a significant source of the Valley Fever fungus. Thus, together with the finding that the bulk of the fugitive dust particles are in the non-respirable range appear to rule out the possibility of Valley Fever posing a health problem in the vicinity of Fort Irwin.

On the basis of the above considerations, it is safe to conclude that though fugitive dust may be a nuisance and may reduce visibility in some areas, it is not a significant threat to public health.

B3.3.3 Vegetation

A. General

Continued use of range and maneuver areas on Fort Irwin will continue to cause damage to vegetation. The principal sources of damaging effects are the use of tracked and wheeled vehicles on the desert, the establishment of bivouac campsites, and the impact of live fire ordnance. Other incidental impacts will also occur from such activities as cutting vegetation for garnishing camouflauge nets.

While there have been few studies of the impact of military use of the desert, there is a growing literature on the effects of motorcycle and off-road vehicle (ORV) use. The findings of several recent field studies of the effects of motorcycle races and ORV use have been summarized by the desert planning staff of the Bureau of Land Management.

The effects of military use on desert vegetation are for the most part the same as those caused by recreational ORV use:

- Reduction of shrub density.
- Reduction of canopy of individual shrubs.
- Reduction of diversity of shrub species.
- Reduction of diversity of annual and perennial herbaceous species.
- Reduction of numbers of annual wildflowers germinating and flowering in following years.
- Increase of density of weedy species.
- Impaired plant growth from increased dust.
- Impaired plant growth due to soil compaction.
- Defoliation, flower, leaf and root injury, mortality.
- Degradation of soil biota and nutrients.

Desert vegetation is damaged by being hit or run-over, by the shearing action on the soil and by soil compaction.

Plants losing branches as a result of being hit or run-over, may recover easily unless roots are broken, and may even experience an increase in growth by what amounts to pruning.

Shearing action caused by a track or tire adjacent to a shrub may promote erosion, the loss of soil around roots, and the subsequent death of the plant (Wilshire, 1977).

The most serious and widespread effects on vegetation, however, appear to result from soil compaction. Impacts of soil compaction on vegetation must be considered long-term or even permanent with recovery, if at all possible, requiring several decades of non-use.

Several generalizations can be made about plant damage from vehicle use in the desert. The damaging effect of desert use increases proportionately to the level of use; that is, the more vehicles using an area, the greater the damage to vegetation. Damage is intensified with repeated use: repeated use increases the period required for recovery, and repeated long-term use eliminates the potential for recovery.

Areas of little vehicle use on Fort Irwin show little long-term effects on vegetation from one-two passes of tracked vehicles. In an area of Fort Irwin and the Naval Weapons Center used for maneuvers 11 years previously, it was found that a tremendous amount of destruction must take place before a statistically significant difference in plant population appears between tracked and untracked areas of the desert (Barling, 1975).

In studying the effects of motorcycles and ORVs, it was found that in randomly driven areas, shrubs were not severely damaged and were able to resprout, but that shrubs damaged in the spring exhibited retarded growth due to low root carbohydrate reserves (Vollmer, et. al., 1976).

With repeated vehicle use, the effects on vegetation increase in severity and permanence. The time expected for recovery of the creosote bush scrub community subjected to intensive vehicle use ranges from estimates of 50 years to not at all (Bureau of Land Management, 1977). Figure 17 shows a part of the Rockpile range south of the cantonment area repeatedly used by tracked vehicles in turning and climbing exercises. While the distribution of vegetation appears not to be affected greatly, the size and vigor of the individual plants is reduced. Recovery of vegetation in this area, should it be undisturbed, may take several decades.

Tank trails, heavily used training courses (e.g., Tank Platoon Battle Run) and maneuver areas show evidence of permanent elimination of vegetation. Repeated use has eliminated vegetation and altered the soil surface permanently. Recovery of such heavily used areas of Fort Irwin is extremely doubtful even if no traffic were permitted on the area.

Bivouac sites are other areas which receive heavy use in the desert and are analogous in their impact to camping areas, pit areas, and start or finish lines for motorcycle and dune buggy races. Such concentrated use areas have been found to be more severely impacted than race courses themselves (Bureau of Land Management, 1977). Field investigations by Naval Weapons Center biologists of a bivouac site in Panamint Valley occupied by 555 Navy seabees and 39 vehicles for four days noted large-scale destruction of vegetation in a concentrated one-hectare area from compaction by foot and vehicle traffic. Reuse of the same bivouac sites will result in long-term destruction of vegetation and little opportunity for recovery.

B. Rare Plant Species

Numerous examples have been found of Mojave Indigo Bush (<u>Dalea arborescens</u>), a federally classified threatened or endangered species, on Fort Irwin in canyon mouths and washes in the Granite Mountains along the Old Randsburg Road (Barling, 1975) and near Garlic, Jack, and Cave Springs (W.R. Powell, California Native Plant Society).

The ecology of Mojave Indigo Bush has not been studied extensively. It is reported to occur in Mono County, the Panamint Mountains, Oro Grande, Hinkley, Rainbow Basin, and the Barstow area, and other locations on the Mojave Desert. It is a brittle plant, and vulnerable to impacts by vehicles; but its sensitivity to pruning, the probability of recovery or mortality of damaged plants, reproduction potential and the resilience of the present population are not known.

The effect of proposed increase in use of Fort Irwin on the population of Mojave Indigo Bush is not known and will depend upon several factors: the distribution of the species on Fort Irwin which, aside for the location of a few plants, is unknown, and the future level of vehicle use in areas where Mojave Indigo Bush is found.

To prevent damage to the Mojave Indigo Bush population, two steps could be taken. First, biological field investigations could be made to determine the geographical distribution. Second, using information on the distribution, a protection plan could be developed and implemented to restrict vehicle use in areas where Mojave Indigo Bush exists.

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B3.3.4 Wildlife

There are two direct ways in which wildlife populations are impacted by wheeled and tracked vehicle use in the desert. These are by immediate death from being run-over or being crushed in burrows under the ground's surface, and by destruction of habitat, which is by far the most serious threat to desert wildlife.

A. Habitat Destruction

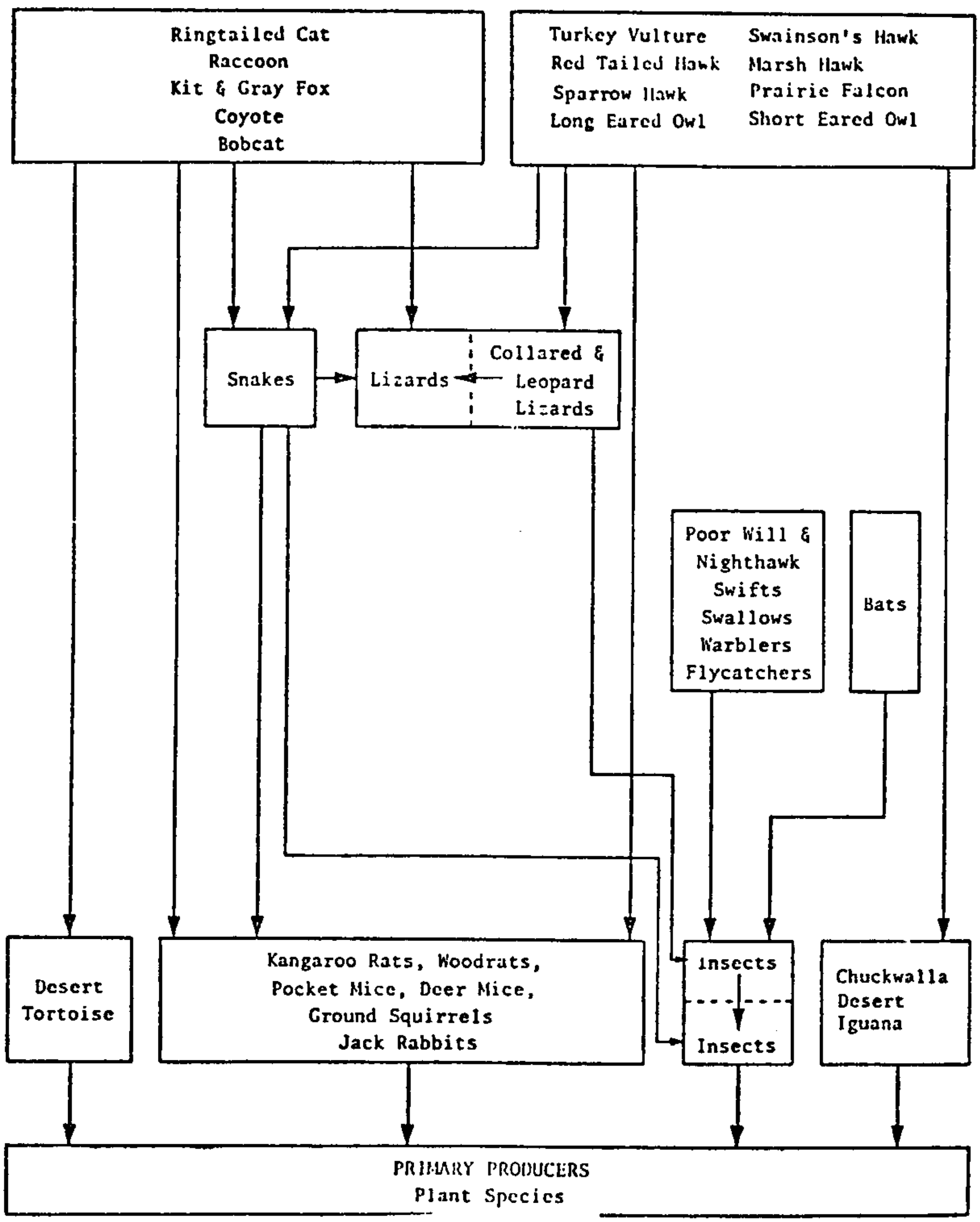
Habitat destruction is the most serious effect of desert vehicle use on animal populations. The effects are widespread and long-lasting. Loss of habitat -- food, cover, nests, and burrows -- reduces the carrying capacity of the land for animal life: as animal habitat decreases in the long run, so will animal populations. For exampls, animals die and populations may be reduced because burrowing species are unable to find cover and become easy prey for predators, or they may simply die of exposure. Likewise, nesting species finding a reduction or elimination of nesting sites will produce fewer young.

Destruction of habitat tends to affect all species in the natural community as the food chain is interrupted. Population changes of herbivorous species of insects, reptiles and mammals that experience a reduction in food supply will affect the food supplies of insectivorous and carnivorous species further up the food web (see Figure A-5).

Most small rodents, many insects and a few reptiles and birds are herbivores. These animals will be affected by a reduction in vegetation. Reduction in populations of herbivorous insects will affect insectivores, for example, lizards, flycatchers and certain snakes (Bureau of Land Management, 1977). Predators are dependent upon populations of herbivores, insectivores, and other carnivores in the desert, and their numbers will decrease if food sources become relatively scarce.

Predators -- grey fox, kit fox, badgers and coyotes -- live around water sources in the desert not just for the abundance of prey, but also because they need water. Naval Weapons Center biologists found evidence of coyotes digging for water at Mesquite Springs (Barling, 1975). Implementation of a wildlife management plan for Fort Irwin has resulted in the springs near heavily used training and maneuver areas being placed off limits to maneuvers. To the extent that the areas around the springs continue to be protected, the wildlife frequenting these areas may be spared direct damage.

Figure B-1 Generalized Food Web



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The feral burros may be affected by continued military activity at Fort Irwin, although because of their mobility and seclusive habits, they may continue to share their range with the Army.

Desert bighorn sheep are also known to live on the Fort Irwin reservation, principally in the Granite and Avawatz Mountains (Barling, 1975). While it is possible that greater danger exists to the bighorn from zealous big game trophy hunters than from military use of the Fort Irwin reservation, the loss of forage may have a detrimental effect on these animals.

Soil compaction will directly and indirectly impact wildlife by collapsing burrows, making the soil more dense and harder to burrow in, and altering soil temperatures. Mortality of dormant reptiles through soil compaction by tracked and wheeled vehicles is a significant possibility. In the wintertime, for example, dormant reptiles bury themselves in the soil from three to eighteen inches deep (Barling, 1975). In loose unconsolidated soil, reptile burrows are extremely susceptible to damage and can be caved in by the weight of a man.

Susceptible reptiles are: banded gecko, desert iguana, zebra-tailed lizard, Mojave fringe-toed lizard, leopard lizard, side-blotched lizard, desert horned lizard, western whiptail, desert tortoise, Mojave patch-nosed snake, glossy snake, western shovel-nosed snake, and sidewinder (Bureau of Land Management, 1977).

Many small mammals are also susceptible to crushing and burrow damage. Mammals that will be affected include antelope ground squirrel, little pocket mouse, long tailed pocket mouse, desert pocket mouse, Merriam's kangaroo rat, desert kangaroo rat, canyon mouse, grasshopper mouse, and desert woodrat (Bureau of Land Management, 1977).

B. Protected, Rare or Endangered Species

The effect of continued use of Fort Irwin on the survival of protected, rare or endangered species is not known, as numerous factors are responsible for the current population levels of these species. Of the protected, rare or endangered species that may be expected to inhabit portions of the Fort Irwin Reservation, four live on or beneath the desert surface. These are the Mojave ground squirrel, a rare species; the desert horned lizard, not officially listed as rare or endangered, but identified by the Bureau of Land Management as locally scarce; the desert tortoise, protected as the California state reptile; and the banded gecko, also identified by the Bureau of Land Management as locally scarce. Among other factors, the continued use of Fort Irwin for military maneuvers can be expected to place a stress on the habitat reduction. All four animals, if present, would inhabit the broad alluvial valleys of Fort Irwin to be used for training and maneuvers. The areas to be used by Forces Command (see Figure 2) when combined with training areas and ranges used by the California National Guard (see Figure 10) preclude the expansion of the existing wildlife management program (see Section 2.8.3) to any unused portions of the Fort of potential value to these species.

The prairie falcon, considered a rare bird by the U.S. Department of the Interior, may inhabit Fort Irwin. Its flight capability better equips it to escape direct harm from military maneuvers, but again destruction of habitat and reduction of population of prey species on Fort Irwin may be detrimental to the prairie falcon population.

B3.4 ARCHAELOGIC AND HISTORIC RESOURCES

Areas of Fort Irwin offer a potentially fruitful field for chronological reconstruction of the aboriginal cultures of the Upper Mojave Desert and a detailed reconstruction of adaptation by pre-historic man to a changing environment with an explanation of those changes. Disturbance of such sites by vehicular travel or human activity, whether deliberate or inadvertent, destroys sequential evidence from which the professional archaeologist derives significant information. The nature of many of the artifacts is surficial, and they are therefore especially sensitive to disturbance.

A contract will be initiated by the Army, upon transfer of operational control from the State of California, for an archaeological field reconnaissance of the Fort and a necessary on-going evaluation of the cultural resources. These will follow the procedures established in Army Regulation 200-1, Chapter 8, entitled "Historic Preservation". Each site found will be evaluated against criteria necessary for inclusion in the National Register. Exact mitigation measures, including "salvage archaeology" whereby sites are well documented before removal of artifacts, will then be recommended to protect the cultural resources from the destruction which could potentially occur.

This preservation program will work to ensure that the potentially severe impact of brigade and joint training exercises on Fort Irwin's archaeologic resources will be minimized.

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B3.5 AESTHETIC QUALITY

Vehicular use of ridges, alluvial fans, bajadas and low hills for tactical maneuvers will cause two effects:

- Create new scars across the landscape which will endure for varying lengths of time depending upon use.

- Intensify existing surficial marks while lengthening the recovery time with each use to the point where a return to a natural state will not occur.

The extent of existing "tank trails" which can be considered permanent marks on the face of the desert is considerable.

The amount of change will be commensurate with the amount of maneuvers. Many trails will be reused, as it is easier to navigate tracked vehicles, where long distances are concerned, on established trails. However, individual vehicular maneuvers will continue to add to the appearance of trails over the natural state, working towards a new landscape where the original character will, in places, be subordinate to the modifications.

As the scenic quality of Fort Irwin has already been modified to a great degree through use and as its visual sensitivity is low except for the Avawatz Mountain area, the National Training Center's impact on the Fort's aesthetic qualities will be minor.

B3.6 RADIO FREQUENCY INTERFERENCE

Electronic warfare operations associated with the proposed mission will increase over the present use of such equipment on the base. In the past, electronic warfare by aircraft over Fort Irwin is believed to have caused unannounced jamming of the communication systems of the Goldstone Deep Space Communication Complex for the various space probes for which it is responsible. Should such communication be interrupted during a critical maneuvering period for a space probe, the entire mission would be jeopardized. The potential for incidence of radio frequency interference will increase with increased use of such equipment.

Electronic warfare activities at Fort Irwin will be coordinated in advance with the National Aeronautics and Space Administration/Jet Propulsion Laboratories at Goldstone, the U.S. Naval Weapons Center, the Federal Communications Commission, and the Occupational and Safety Health Administration to avoid any conflicts.

B3.7 ENERGY

As a worst case condition, the Army projects the following level of vehicle fuel consumption per year during operations:

Jet Fuels	-	30,000 barrels
Mogas	-	6,017 barrels
Diesel	-	33,994 barrels